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The Abdominoinguinal Incision: The Equivalent of Thoracoabdominal Incision for the Lower Quadrants of the Abdomen

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In the past, tumors of the iliac fossa, those of the area of the external iliac vessels, and those fixed to the wall of the lesser pelvis with extension into and involvement of the pubic bone were often considered unresectable through the conventional surgical incisions or were treated with hemipelvectomy. For such tumors, although there was exposure of the cephalad aspect through routine incisions, there was lack of exposure on the caudal or lateral aspects, which often extended anteriorly to involve the lower abdominal wall or continued behind the inguinal ligament or through the obturator foramen into the thigh. The abdominoinguinal incision provides exposure for resection of the majority of these tumors with preservation of the extremity. It involves a lower midline incision, which is extended from the pubic symphysis transversely to the midinguinal point on the affected side and then vertically for a few centimeters in the femoral triangle. The femoral vessels are exposed, the ipsilateral rectus abdominis and anterior sheath are divided off the pubic crest, the inguinal ligament is divided off the pubic tubercle, the inferior epigastric vessels are ligated and divided near their origin from the vessels, and the lateral third of the inguinal ligament is detached from the iliac fascia. This incision provides full exposure of the lower abdominal aorta, inferior vena cava, and iliac vessels on the side of involvement in their continuity with the femoral vessels. With improved exposure and vascular control, the majority of tumors with lateral pelvic fixation become resectable.

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KEY WORDS: resection; tumors; pelvis; fixation

INTRODUCTION

In the upper quadrants of the abdomen, an upper midline, paramedian, subcostal, or the so-called chevron incision suffice for resection of the average tumor. However, for large tumors in the upper quadrants of the abdomen, such as retroperitoneal sarcomas, a thoracoabdominal incision is required and can be done safely. This involves an incision into the upper abdominal wall as well as into the lower chest, and by transection of the costal margin and incision on the periphery of the diaghram, the presentation in a single operative field of the respective upper quadrant as well as the adjacent portion of the ipsilateral thoracic cavity becomes feasible. Such an incision provides exposure in continuity with both the abdominal and thoracic cavities and immensely facilitates the resection of tumors located near the junction of these two cavities. Until recently, we did not have an incision in the lower quadrants of the abdomen, which could be considered the counterpart of the thoracoabdominal incision.

Tumors in the iliac fossa, usually sarcomas, may extend along the substance of the iliopsoas muscle into the upper groin behind the inguinal ligament or from the

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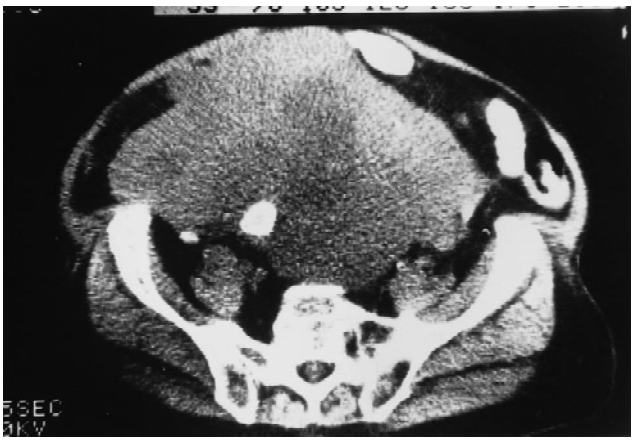

Fig. 1. Liposarcoma of the lower abdomen extending over the iliac vessels to the right iliac crest, found to be unresectable elsewhere through a midline abdominal incision, was removed through a right abdominoinguinal incision.

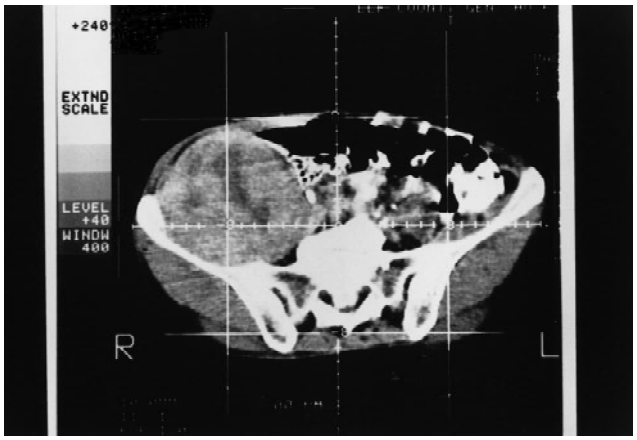

Fig. 2. Sarcoma of the right iliac fossa superficially involving the iliac bone.

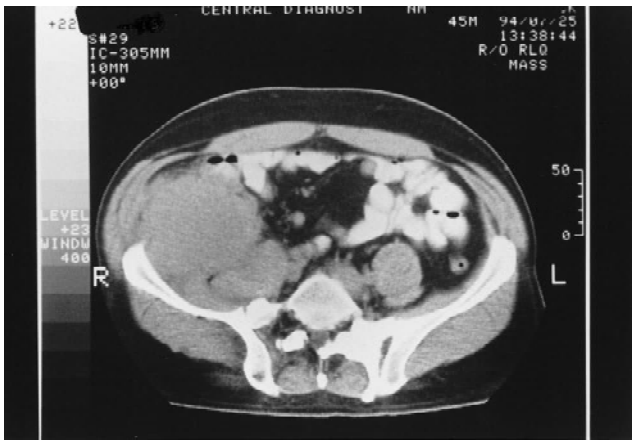

Fig. 3. Sarcoma of the right iliac fossa involving the iliac vessels.

depths of the iliac fossa all the way to the posterior surface of the anterior abdominal wall (Figs. 1–3). This makes it difficult or impossible to resect these tumors through the conventional abdominal incisions.

Large tumors or nodal masses over the external iliac vessels, tumors attached to or on the wall of the lesser pelvis, and tumors involving the pubic bone or extending from the lower pelvis through the obturator foramen into the adductor group of muscles cannot be resected through the conventional abdominal incisions. Through a lower midline incision or an oblique incision in the lower quadrant, one may expose the cephalad aspect of such tumors and perhaps control the ipsilateral common iliac artery near its origin from the aorta or the common iliac vein at the confluence of the iliac veins to the inferior vena cava, but there is no distal exposure and control on the distal external iliac or femoral vessels. A number of these tumors either are considered unresectable or a hemipelvectomy is performed for their resection because of the lack of distal exposure. An incision, therefore, which would, by definition, provide exposure in continuity with the lower abdomen and the groin on the right or left side should include an abdominal and an inguinal component in one continuous line. Such an incision can be called an abdominoinguinal incision. The abdominoinguinal incision developed in the background of the anatomic knowledge available from the technique of radical groin dissection with dissection in continuity of the inguinal, external iliac, obturator, and common iliac nodes [1].

OPERATIVE TECHNIQUE

In the *radical groin dissection,* for exposure in continuity, the inguinal ligament is divided lateral to the femoral artery and the anterolateral abdominal wall muscles are divided from the point of intended division of the inguinal ligament lateral to the femoral artery to about two finger breadths superomedial to the anterior superior iliac spine. The external oblique, internal oblique, and transversus abdominis muscles are first divided, and then the inguinal ligament is divided about half an inch or so lateral to the femoral artery. The inferior epigastric artery and vein are ligated and divided close to their origin; this allows opening of the retroperitoneal space in continuity with the femoral vessels and the inguinal lymph nodes. The exposure provided through the incision of the radical groin dissection is, however, totally inadequate for the resection of a large sarcoma in the iliac fossa or even for matted large masses of lymph nodes in the area of the external iliac vessels. For such tumors, the *abdominoinguinal incision* provides adequate exposure. A lower midline incision is performed starting either immediately below the umbilicus or above the umbilicus and then to the right or left of the umbilicus, depending on the location of the pelvic tumor. The incision is carried down to the pubic symphysis. The incision is deepened through the subcutaneous fat to the linea alba, which is incised,

and then the peritoneum is opened. An exploration is then performed to allow assessment of the extent of disease and to rule out metastatic disease in the liver or other intraperitoneal sites. Some preliminary dissection may be performed, such as separating the sigmoid colon or the cecum off the surface of a retroperitoneal mass in that area. Involvement of bowel, of course, does not preclude a resection. The mass may appear to be fixed, but this does not denote unresectability because normal anatomic structures, such as the iliopsoas muscle, are themselves fixed and not easily moveable. The incision is then extended from the pubic symphysis transversely along the pubic crest to the midinguinal point on the side of involvement and from this point vertically downward to the apex of the femoral triangle.

In the case of a tumor involving also the lymph nodes, when inguinal and deep node dissection is desired, thin flaps may be raised at this point from the vertical portion of the incision, which is carried (as mentioned above) from the midinguinal point to the apex of the femoral triangle. The medial flap is developed toward the anterior border of the gracilis and the lateral flap to the lateral border of the sartorius muscle. The investing fascia then is detached from the surface of the superficial layer of the adductor muscles (i.e., pectineus and adductor longus) to the point where the medial wall of the common femoral and superficial femoral veins is exposed. The vein is seen through the sheath covering it, which is entered and dissected off the wall of the vein until the insertion of the great saphenous vein into the common femoral vein is encountered, suture-ligated with a transfixion ligature, and divided. The division of the great saphenous vein is done in this fashion deep to the foramen ovalis. Of course, the great saphenous vein is divided more distally near the apex of the femoral triangle as it courses through the subcutaneous fat. Laterally, the fascia on the anterior surface of the sartorius muscle is stripped off the muscle, the lateral aspect of the femoral artery is exposed, and again the sheath of the artery is entered. Small tributaries from the artery to the specimen are ligated and divided and the adipose tissue and lymph nodes are elevated off the surface of the superficial femoral artery and vein toward the inguinal ligament. Above the inguinal ligament also the flap is developed in order to remove and dissect toward the specimen, the lymph nodes over the spermatic cord or around the ligament and those present over the lower portion of the external oblique aponeurosis. The specimen of the lymph nodes is thus mobilized but is left attached to the femoral canal area in order to be removed in continuity with the deep nodes, if indeed lymphadenectomy is required. However, in most cases, certainly in those involving sarcomas or other tumors in the lower regions of the retroperitoneal area, it is not necessary to dissect the inguinal nodes. Therefore, after the vertical portion of the skin incision is made in the femoral triangle, the dissection is carried straight down to the surface of the common and superficial femoral vessels, which are exposed. Loops may be passed around both femoral artery and vein for distal control. Following exposure of the femoral vessels, the anterior rectus sheath and rectus abdominis on the same side are divided off the pubic crest and then the inguinal ligament is divided at the pubic tubercle. As this is done, the peritoneum also is incised in a caudal and lateral direction lateral to the outline of the urinary bladder. Although the transverse portion of the incision passes over the spermatic cord in the male, it is possible to save the spermatic cord if the components of the cord are not involved by the tumor. In order to do so, the cord is encircled with an umbilical tape or vessel loop and the inguinal canal is opened from the deep side by incising the transversalis fascia all the way to the internal inguinal ring. This allows extrication of the spermatic cord off the inguinal canal, and at this point, deep to the internal ring, the spermatic cord is seen to bifurcate into its components, i.e., the vas deferens, which follows a medial direction toward the spermatic vesicles, and the internal spermatic vessels, which follow a cephalad course (Fig. 4). Ligation of the spermatic cord deep to the internal ring does not apparently jeopardize the viability of the ipsilateral testis, provided the testis has not been mobilized off its scrotal cavity, whereby it receives small vessels from the skin of the scrotum. As the inguinal ligament is lifted from the medial point where it was divided off the pubic tubercle, the inferior epigastric vein can be visualized at its point of insertion into the external iliac vein and ligated and divided at this level. Similarly, the inferior epigastric artery can be ligated and divided at its origin from the external iliac artery (Figs. 5, 6). The lateral third of the inguinal ligament, i.e., the portion lateral to the artery which is normally fused with the iliac fascia, can be sharply separated from the fascia, thus completing the

Fig. 4. Operative field following resection of a sarcoma in the right iliac fossa. Exposed is the iliac bone. The spermatic cord has been preserved.

Fig. 5. Exposed large sarcoma in right iliac fossa (same as in Fig. 2). The inferior epigastric vessels are surrounded with vessel loops.

Fig. 6. The inferior epigastric vessels shown in Figure 5 have been ligated and divided. The femoral nerve has been exposed and the tumor in the right iliac fossa mobilized. Its resection required removal of the iliac bone above the acetabulum.

opening of the operative field. As the abdominoinguinal incision is completed, one has in a single operative field the lower portion of the abdomen, the pelvis, and the groin ipsilateral to the tumor exposed with the vessels from their origin at the aorta or confluence to the inferior vena cava all the way down to the femoral triangle. Vessel loops may be passed around the origin of the common iliac artery at the bifurcation of the aorta and around the femoral artery so that there can be proximal and distal control of the artery. As the exposure and dissection around the vein continue, the same procedure can be repeated for the femoral and iliac veins, respectively. Dissecting the vessels by entering their sheath on the side away from the tumor is, of course, ideal as long as the vessels are not grossly involved. For sarcomas of the iliac fossa, the iliac fascia is incised immediately lateral to the external iliac artery at the level of the divided inguinal ligament and underneath the iliac fascia, often covered by a small amount of adipose tissue, the femoral nerve

Fig. 7. Operative field following resection of a sarcoma in the right iliac fossa. Exposed are the iliac and femoral vessels and the femoral and obturator nerves.

can be exposed. The femoral nerve courses in the iliac fossa between the iliacus and psoas muscles and becomes quite superficial at the level of the inguinal ligament located immediately underneath the iliac fascia. The femoral nerve is encircled by a vessel loop below the inguinal ligament and then dissected in a cephalad direction; in most cases, it can be preserved. If the tumor is found to be directly invading the femoral nerve, there should be no hesitation to sacrifice the femoral nerve if otherwise complete resection of the tumor can be performed. One drawback following resection of the femoral nerve is the inability to extend actively the ipsilateral knee, but after a 2- to 3-month period of rehabilitation, patients learn to passively extend the knee joint as they walk and apparently can ambulate in most cases without the use of any external support, such as a cane.

Soft tissue sarcomas of the iliac fossa can be resected, using the cautery and the periosteal elevator and, thus, stripping the periosteum off the surface of the iliac bone and mobilizing the iliacus and the psoas en bloc with the tumor (Figs. 7, 8). The psoas originating from the lumbar spine has to be divided from its origin, taking care to preserve the femoral nerve and its roots. In cases of nodal involvement, the specimen of the superficial groin dissection remains connected with the external iliac and obturator nodes as the dissection continues on the surface of the external iliac vessels and then medial to the wall of the external iliac vein on the surface of the pelvic fascia. This is the fascia covering the obturator internus muscle. Dissection including the obturator nodes means dissecting from the level of Cooper's ligament to the internal iliac artery and from the medial wall of the external iliac vein to the obturator nerve. The obturator nerve issues from behind the internal iliac vessels and courses along the wall of the lesser pelvis to the obturator foramen. In rare cases, when there is advanced tumor in the obturator nodes, the obturator nerve can be sacrificed without any

Fig. 8. Operative field after resection of sarcoma of Figure 3. The iliac vessels have been replaced with vascular grafts.

appreciable difficulty for the patient in routine ambulation.

For tumors involving the wall of the lesser pelvis, the ureter needs to be dissected off its course over the common iliac vessels and down to its insertion into the urinary bladder. A small portion of the ureter can be resected and the proximal end of the ureter anastomosed to the wall of the bladder, any tension in the anastomosis being relieved by suturing the bladder wall to the psoas or adjacent tissue (Figs. 9, 10). For longer segments of the ureter, one may have to use a conduit of a defunctionalized segment of ileum to connect the proximal end of the ureter to the bladder. In such cases, we have performed an end-to-side anastomosis between the proximal end of the ureter and the side of the ileal segment, followed by another end-to-side anastomosis between the full width of the ileal segment and a suitable opening into the urinary bladder.

For tumors fixed to the wall of the lesser pelvis below the level of the internal iliac vessels, one has to have control of the origin of the internal iliac vessels by passing vessel loops around these structures, certainly the artery which is more superficial to the vein, and then proceed to incise the fascia posteromedial to the external iliac vein. By incising the obturator internus fascia at this level, the fascia may be dissected off the obturator internus, and indeed, the muscle itself can be dissected off the surface of the bone so that one may obtain a desirable margin on the lateral side of the pelvic tumor with ''fixation'' to the wall of the lesser pelvis. In removing the pubic bone through the abdominoinguinal incision, the medial flap of the inguinal portion of the incision is developed along with the horizontal part of the incision until the arch of the public symphysis posteriorly is felt as well as the inferior pubic ramus all the way to the ischial tuberosity. The inferior pubic ramus is detached from the origins of the adductor group of muscles, which have to be divided off the superior as well as the inferior

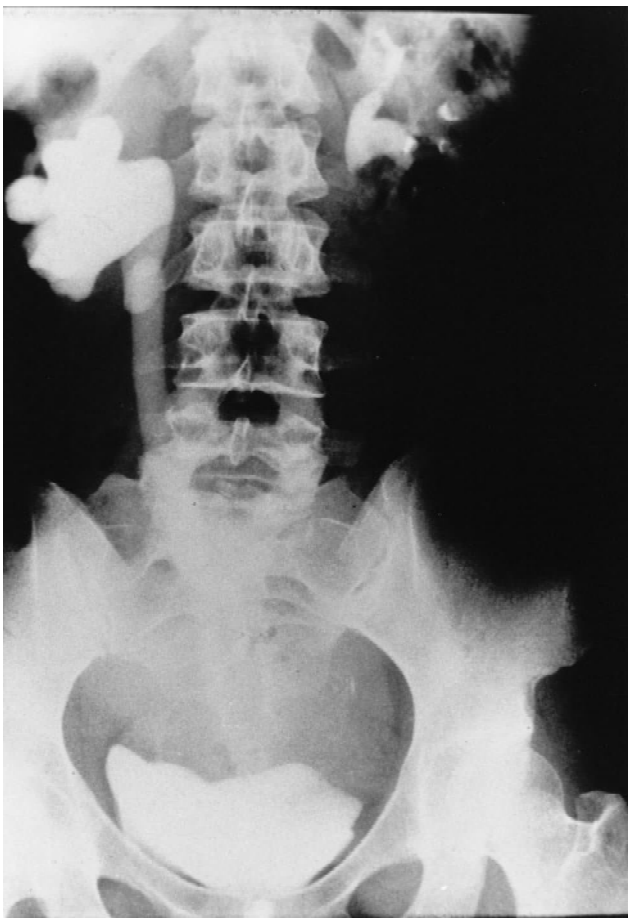

Fig. 9. Intravenous pyelogram showing obstruction of the right ureter by a fibrosarcoma.

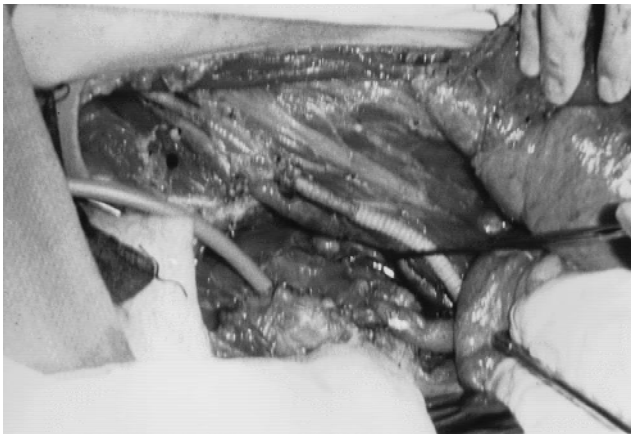

Fig. 10. Operative field after resection of the sarcoma of Figure 9 en bloc with hysterectomy, right salpingoophorectomy, resection of the distal ureter (proximal ureter reimplanted in the bladder), and external iliac artery (replaced by a vascular graft).

pubic ramus. In the process of dividing the origin of adductor muscles from the pubic bone, the obturator nerve and vessels and their branches coursing between the layers of adductor muscles have to be ligated and

Fig. 11. Resection of the left pubic bone en bloc with a soft tissue sarcoma involving the bone. The defect has been covered by a mesh. The rotated sartorius covers the vessels, preventing direct contact between the latter and the mesh.

Fig. 12. Operative field after resection of the right pubic bone. The defect is covered by a mesh.

Fig. 13. Radiograph of the pelvis after resection of the right pubic bone.

divided. A Gigli saw is placed around the superior pubic ramus close to the acetabulum, around the pubic symphysis, and around the inferior pubic ramus close to the ischial tuberosity, and the bone is divided at these three sites. This permits removal of the pubic bone en bloc with adjacent soft tissues and tumor (Figs. 11–14).

Closure of the uncomplicated abdominoinguinal incision is fairly straightforward. Interrupted nonabsorbable sutures are placed between the inguinal ligament and iliac fascia lateral to the femoral artery, taking care to avoid ensnaring the femoral nerve. Medial to the vessels, the inguinal ligament is approximated with interrupted non-absorbable sutures to Cooper's ligament and, further, the rectus abdominis muscle and anterior rectus sheath are approximated with interrupted sutures to the pubic crest. If a node dissection has been performed, raising the possible postoperative risk of flap necrosis and exposure of the vessels, one may be well advised to mobilize the sartorius off its origin from the anterior superior iliac spine and bring it over to cover the femoral vessels. The amputated end of the sartorius is sutured to the inguinal ligament in a position which will maintain the muscle in front of and covering the femoral vessels. A closed suction drain is placed in the inguinal portion of the incision, the subcutaneous fat is approximated with absorbable interrupted sutures, and the skin is closed with staples. The midline portion of the incision is closed

Fig. 14. Chondrosarcoma involving the right anterior pubic ramus and extending to the right groin, which was removed through a right abdominoinguinal incision.

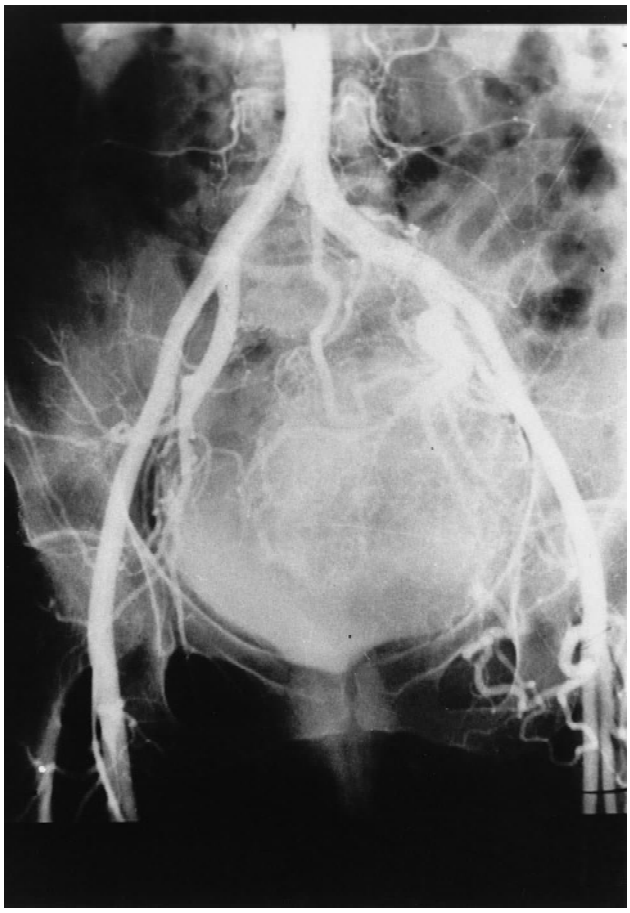

Fig. 15. Angiosarcoma of the pelvis, which required for its resection a bilateral abdominoinguinal incision.

in a routine fashion by approximating the fascia and then the skin.

MODIFICATIONS OF THE ABDOMINOINGUINAL INCISION

This incision can be extended bilaterally for a midline pelvic tumor which extends over to both sides to cover the distal portions of the external iliac vessels. In such a case, one may start with the lower midline incision from above the umbilicus down to the pubic symphysis, and then from the pubic symphysis the incision may be carried out transversely toward the middle of the inguinal ligament on both sides. The rectus abdominis muscle and the anterior rectus sheath are divided off the pubic crest bilaterally. This type of T incision is often sufficient to provide exposure for the resection of a large midline pelvic tumor. With this incision, the distal portions of the external iliac vein are exposed bi-laterally and the area of Cooper's ligament and obturator nerve is also exposed. For further exposure, one can truly extend the incision in the manner of the abdominoinguinal incision, i.e., by extending it from the midinguinal point vertically along the imaginary course of the femoral vessels to the apex of the femoral triangle. The femoral vessels are exposed bilaterally and the inferior epigastric vessels are ligated and divided. This will provide exposure of both groins and femoral vessels of both sides in continuity with the external iliac vessels on the right and left side all the way to the bifurcation of the aorta (Fig. 15). However, in the majority of cases, the T incision, which is simple and involves a lower midline incision extending from the pubic symphysis to the pubic tubercle on both sides transecting the rectus abdominis bilaterally, provides ample exposure for a midline pelvic sarcoma which may extend low on both lateral sides to the obturator foramen.

Another modification of the abdominoinguinal incision is called for when there is involvement of the deeper layers of the anterior abdominal wall. With such involvement, as the external oblique and anterior rectus sheath are divided off the pubic crest and the inguinal ligament is divided at the pubic tubercle, one may dissect between the external oblique aponeurosis and the deeper layers, i.e., the internal oblique, so that a portion of these layers which may be attached to the tumor may be left on the surface of the tumor. If indeed this can be done, then of

course there is no problem with reconstruction because one would have at least the anterior fascial layer, i.e., the layer of the external oblique and its continuation into the anterior rectus sheath. If there is more extensive involvement of the anterolateral abdominal wall muscles above the inguinal ligament, then one may have to remove the entire thickness of these muscles, in which case a repair with a mesh may be performed at the completion of the resection. If a mesh is used to replace the lower part of the abdominal wall muscles all the way down to and including the inguinal ligament, one has to avoid direct contact between the mesh and the external iliac or femoral vessels because such contact may cause erosion of the artery by the mesh and hemorrhage either in the immediate postoperative period or later. In such cases, it is crucial if a mesh is to be used to transpose a muscle, such as the sartorius, to cover the femoral artery and vein so there will be no direct contact between the mesh and these vessels. It is preferable, however, to avoid altogether the use of a mesh in cases of resection of this portion of the lower abdominal wall muscles because in the postoperative period the mobilized sartorius may shift and contact between the vessels and the mesh may be permitted. It is therefore preferable to use a rotation flap by mobilizing the contralateral rectus abdominis to cover such a defect. In this case, the linea alba on the contralateral side is incised along its length, permitting separation of the anterior and posterior rectus sheath, and the contralateral rectus abdominis is divided just below the costal margin and mobilized together with the posterior rectus sheath and peritoneum so that the inferior epigastric vessels, coursing between the posterior surface of the rectus abdominis and the posterior rectus sheath and peritoneum, can be preserved intact, providing a blood supply to the muscle. The muscle, supported posteriorly by the posterior rectus sheath and peritoneum, provides a sturdy layer for the safe reconstruction of the lower abdominal wall muscles, which can reach all the way to the iliac crest (Fig. 16). The inferior border of the muscle flap is sutured lateral to the vessels to the iliac fascia or iliopsoas muscle (taking care to avoid ensnaring the femoral nerve in the sutures) and medial to the vessels to Cooper's ligament and pubic crest. The superior border of the muscle is sutured to the edge of the anterolateral abdominal wall muscles.

In the case of a prior lower abdominal oblique incision, one may have to modify the course of the abdominoinguinal incision because otherwise one might create a very narrow area of skin that is deprived of any blood supply coming from the intercostal vessels or from branches of the femoral artery. Therefore, if there is an incision over the lower abdominal quadrants, e.g., above the inguinal ligament, after making the midline portion of the abdominoinguinal incision and the transverse portion up to the level of the pubic tubercle one may have to incline the incision to follow the course of the previous suprainguinal incision and then, at the midinguinal point, carry the incision vertically toward the apex of the femoral triangle. Again, the purpose is to avoid any narrow strip of skin devoid of blood supply by the placement of two parallel incisions close to each other.

Fig. 16. Mobilized rectus abdominis with posterior sheath and peritoneum to cover a defect in the contralateral groin.

POSTOPERATIVE COURSE

The postoperative course is quite uneventful. As it is a lower abdominal surgery, the risk of pulmonary complications is low. The risk of wound infection is generally low, not higher than with any other conventional incision. If a concomitant groin dissection has been done with this incision, then of course, one may expect lymphorrhea through the suction drains for a period of 2 weeks or so. With the exception of cases in which a flap was developed between the skin-subcutaneous fat layer and the external oblique aponeurosis and in which a prior oblique incision in the ipsilateral quadrant of the lower abdominal wall had been made, there have been no instances of skin edge necrosis in any part of this incision. There have been no instances of incisional hernia be-

cause the repair following this incision is a Cooper's ligament repair used to reconstruct the shelving edge of the inguinal ligament to Cooper's ligament.

Two patients experienced bleeding from the external iliac artery due to erosion by a reconstruction mesh which was adjacent to the artery. In both patients, the area of the artery had been previously irradiated. One of these patients was repaired with an axillofemoral bypass, while the other patient succumbed to retroperitoneal bleeding due to delay in diagnosing the bleeding, which occurred about 2 weeks postoperatively. Of 150 patients operated with the abdominoinguinal incision, two died postoperatively: one mentioned above from erosion of the external iliac artery by a mesh that had been placed to repair a fascial defect which included the inguinal ligament and one from pulmonary embolism on the seventh postoperative day.

DISCUSSION

If a tumor is located in the lower regions of the peritoneal cavity, where the retroperitoneal tissues merge with the abdominal wall, there is lack of exposure through the conventional abdominal incisions. Patients with tumors in the iliac fossa were considered in the past unresectable or were treated with hemipelvectomy. The majority of these tumors now are resectable through the abdominoinguinal incision, with survival depending on the margin of resection and the histologic grade of the tumor. The abdominoinguinal incision has been used successfully in three cases of colonic adenocarcinoma, two involving the sigmoid colon and producing an exophytic growth through the anterior abdominal wall, the third having a cecal adenocarcinoma extending into the iliopsoas muscle. One patient survived 2.5 years after resection of sigmoid adenocarcinoma, when he died from metastatic disease, and the other two are alive and disease-free 1.5 and 1 year, respectively, following resection of the tumor.

The pivotal anatomic point is that of the inferior epigastric vessels and the realization that these vessels need to be ligated and divided near their origin for the inguinal ligament to be mobilized off of them. By dividing the inguinal ligament either lateral to the artery as in the radical groin dissection or at the pubic tubercle as in the abdominoinguinal incision, one can have a wide opening of the space and exposure in continuity with the groin and pelvis. This is also important for the technique of internal hemipelvectomy, which allows direct exposure of the iliac-femoral vessels and their mobilization with complete visibility as the hemipelvis is resected [2].

The abdominoinguinal incision is a formal incision for the opening of the retroperitoneal space in continuity with the ipsilateral groin or bilateral groin for tumors which are fixed to the wall of the greater or lesser pelvis [3–7]. It is the equivalent of the thoracoabdominal incision for the lower quadrants of the abdomen and can be carried out with minimal morbidity and certainly minimal mortality. It is also the only incision which provides exposure in continuity with the dissection of the inguinal, external iliac, obturator, common iliac, and preaortic or precaval lymph nodes in cases of extensive involvement of this lymphatic nodal chain by melanoma or any other tumor spreading along the lymphatic channels to the retroperitoneal lymph nodes. There is no other incision that provides exposure in continuity with the inguinal, iliac, and preaortic–precaval area.

Although the abdominoinguinal incision has been described previously [3–7], it remains largely unknown. In our experience, it has been an essential component of the surgical armamentarium in raising the resectability rate of retroperitoneal sarcomas from an average of 53% [8] to 96% [9] and 5-year survival from 34% [8] to 66% [9].

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